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RECOMMENDATIONS FOR EQUIPMENT FOR ELECTROPLATING

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RECOMMENDATIONS FOR EQUIPMENT FOR ELECTROPLATING

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RECOMMENDATIONS FOR EQUIPMENT FOR ELECTROPLATING

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 30 April 1964, after the draft finalized by the Metallic Finishes Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 Although the requirements for electroplated coatings on various metals have been covered in a series of Indian Standard Specifications, a need was felt for recommending equipments required for various processes carried out in electroplating industry. This standard was formulated to fulfil this need. This standard will also guide the industry, especially the small scale industries dealing in electroplating, in the selection of right type of equipment for a particular job.

0.3 In the preparation of this standard, due consideration has been given to the manufacturing and trade practices followed in the country in this field. Assistance has also been derived from the following publications:

Canning Handbook on Electroplating, London. W. Canning and Co. Ltd., 1960.

Kenneth Graham, A. Electroplating Engineering Handbook. New York. Reinhold Publishing Corporation, 1962.

0.4 Metric system has been adopted in India and all quantities and dimensions in this standard have been given in this system.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960 Rules for Rounding Off Numerical Values (*Revised*). The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard recommends the equipment required for pre-treatment of metallic surfaces and for processes used in electroplating.

2. POLISHING SHOP AND ITS EQUIPMENT

2.1 Important Requirements of a Polishing Shop — Polishing shop shall be well-ventilated and well-lighted. Since polishing operations carried out mechanically produce considerable dust and linter, a dust extracting system should be provided to prevent them from reaching other sections of the plant.

NOTE — The electrolytic and chemical processes for polishing and brightening of metal may be carried out in the plating shop itself.

2.2 Equipment — Polishing machines commonly known as polishing lathes could be belt-driven or motor-driven. A self-contained motor-driven polishing lathe fitted with a dust extracting unit may be used. Horsepower of the motor should be such that the speed of the spindle (revolutions per minute) does not fall when the job is polished with reasonable pressure to more than 15 percent of its original rating.

2.3 Barrel Polishing — For polishing comparatively small articles it is more economical and convenient to polish them in rotating barrels. Such barrels are available in the following four types:

a) Open type,
b) Enclosed type,
c) Vibrating type, and
d) Rotating vibrational type.

3. PLATING SHOP AND ITS EQUIPMENT

3.1 Requirement — Dust or dust-laden air shall be avoided in a plating shop. It shall be well-ventilated and shall be provided with exhaust fans.

3.2 Equipment

3.2.1 *Tanks* — Welded steel tanks, suitably lined inside and painted from outside, are used for the majority of electroplating and pre-treatment processes. Different types of tank linings used for pre-treatment processes and electroplating solutions are given in Appendices A and B.

3.2.1.1 In case of tanks with linings, the following important operations shall be carried out prior to use:

a) *Rubber-lined tanks*
  1) *When used with acidic solutions* — Fill the tank with dilute sulphuric acid (approximately 3 to 5 percent v/v). Heat it for at least eight hours at a temperature ranging from 45° to 60°C. The temperature chosen for heating, however, should

be 3°C in excess of normal operating temperature. Remove the acid solution and wash the tank with clean water.

2) *When used with cyanide solutions* — Fill the tank with caustic soda solution (100 g/1) and keep it for at least eight hours. If possible, keep it heated around 50°C. Remove the solution and wash the tank with clean water scouring the lining slightly with fibre or bristle brush. Wash it again before putting to use.

b) *Alloy-lead-lined tanks for chromium plating* — Clean the tank and fit the reinforced glass lining. Fill up the tank with plating solution and heat to 48°C. It is important that cold solution is not brought in contact with the new lining until the above treatment is carried out.

3.2.2 *Accessories* — The following accessories are required:

a) Insulators,
b) Anode and cathode rods, and
c) Rod connectors.

3.2.3 *Plating Racks* — A contrivance to suspend parts in position in an electrolyte and to conduct current to it. In its simplest form a rack may be a hook made of bare copper wire.

3.2.3.1 In designing a plating rack the following points should be taken into consideration:

a) It should be such that it carries the required current.
b) Significant surfaces should be held in such a manner that they are nearer to the anode.
c) It should be designed to avoid any uneven distribution of deposit.
d) It should have sufficient strength to hold the work piece.
e) There should be sufficient clearance between the top of the work and solution level, and the bottom of work and bottom of the tank should be provided.

The material used for the rack and its insulation, if any, should be such that they do not have any adverse effect due to any reaction with the electrolyte.

4. EQUIPMENT FOR HEATING OF SOLUTIONS

4.1 Heating by Steam — This is carried out by one of the three methods detailed below:

a) *Steam Coil* — Immersion of steam pipe coil in solutions is the most common method employed. The type of coil to be used depends upon various solutions. The following data should serve as a guide:

1) Plain steel coils	For alkaline or cyanide solutions
2) Titanium covered coils	For acidic solutions
3) Tellurium lead coils	For sulphuric acid pickling solution

b) *Steam Injection* — In this method live steam is directly injected. Owing to considerable dilution that may result if steam is directly injected into the solutions, this method is restricted to heat water and water jackets. Each injector should be provided with a pressure reducing valve and a safety valve to restrict the steam pressure to 0·70 kg/cm^2.

c) *Heat Exchanger* — Carbon block heat exchangers are now used in place of pure nickel steam coils for bright nickel plating solutions.

4.2 Heating by Gas — This method makes use of a variety of gas burners and is convenient for heating small tanks.

4.3 Heating by Electricity — This method of heating provides ease in control. Variety of immersion heaters are used for this purpose. Among them the hair-pin types are more commonly employed. The type of heaters, however, depends upon the solution to be heated. The following recommendations would serve as a guide:

Solution	*Type of Heater*
a) Cyanide and alkaline, such as metal cleaner, tin-plating, etc	With steel casing
b) Weak acidic, such as for dull nickel plating	With rolled lead casing over steel or fused silica
c) Bright nickel solution	Fused silica

4.4 Heating by Outer-Jacket — This may be electrically heated by screw-in-type immersion heaters fitted horizontally at the inside bottom of tank. It is advantageous to heat lead-lined tanks by means of water jacket. For rubber-lined tanks this is a difficult problem, but when the amount of heat necessary is not more and the time of heating is not the main factor, then this method may be used.

5. EQUIPMENT FOR COOLING SOLUTIONS

5.1 In certain processes, such as anodizing, it is necessary to cool the solution. This is done by means of cold water cooling coils immersed in the solution. In certain cases, refrigeration may also be employed. Installation of automatic temperature control equipment is recommended.

6. EQUIPMENT FOR AGITATION OF SOLUTIONS

6.1 Agitation is essential to maintain uniformity of concentration in solution as this enables plating to be done at high current density especially in the areas surrounding cathodes. To achieve this, the following types of equipment are employed:

a) Air compressors, pressure reducers and filters;

b) Mechanical reciprocators; and

c) Low-pressure rotary blowers.

NOTE — Installation of automatic temperature control is recommended for these types of equipment.

7. EQUIPMENT FOR FILTRATION

7.1 Filtration of plating solutions is essential if roughness or porosity due to inclusion of suspended matter in the plated deposit is to be avoided. Agitated solutions and those operated at high current density should be continuously filtered. Such baths, therefore, are fitted with filtering units. For other solutions, filtration at regular intervals may serve the purpose. In such cases, a portable filtration unit on wheels is very convenient. The following types of filters which are commonly used are recommended:

a) *Horizontal Plate-filter* — It consists of a horizontal stack of plates enclosed in a body. Filter discs are used on either side of each plate and spacers are usually assembled between the plates so that adequate space is provided in for treatment with solids. This type is mostly used in industry.

b) *Porous-Tube Pressure Filter* — Carbon, stoneware or oven fibre type porous tubes are recommended.

c) *Filter Cloth* — Many of the filters used in plating industry require cloth as a part of the supporting filter medium. Materials commonly used are cotton, nylon, terrylene, dacron and glass.

d) *Filter Papers* — Filter papers of suitable porosity to retain particles of particular size are used as additional filtering media.

8. EQUIPMENT FOR DRYING OF WET ARTICLES

8.1 Rotating barrels are employed for heating saw dust used for drying small articles. Centrifugal dryers or hot air ovens are also used for drying small components. Hot air circulated drying ovens and infra red drying ovens are used for drying bigger articles. These drying ovens may be rotated by means of a conveyer belt.

9. EQUIPMENT FOR ELECTROPLATING IN SMALL BARRELS

9.1 Plating barrels are either belt- or motor-driven. They are available in various sizes to suit production requirements. The following types of electroplating barrels are recommended:

a) Oblique barrels containing the electroplating solution,

b) Perforated oblique barrels submerged in the plating solution contained in a tank,

c) Horizontal perforated barrels immersed in plating solution contained in a tank, and

d) Special chromium plating barrels.

9.2 Recommended types of lining plating barrels are given in Appendices A and B.

10. ELECTRICAL EQUIPMENT

10.1 Rectifier — Output of the rectifier in volts and amperes should suit the process for which it is to be used.

10.1.1 For electroplating purposes, oil-immersed metallic types are very suitable although air-cooled types may be used where very small output is needed as in the case of gilding. Oil-immersed metallic rectifiers of the following two types are suitable :

a) Single-phase sets operating from 240 volts nominal, 50 c/s, single-phase AC supply, and

b) Three-phase sets operating from 415 volts nominal, 50 c/s, three-phase AC supply.

10.1.2 Rectifiers of various outputs and voltage ranges are given in Appendix C.

NOTE — Single-phase rectifier sets are unsuitable for chromium plating. For a majority of plating processes 7·5-volt units are quite suitable but for hard chromium plating a 12-volt set is required and for sulphuric acid anodizing, a set having the maximum output of 16 volts is necessary. For chromium acid anodizing a 40-volt is necessary.

10.1.3 Mercury arc, germanium and silicon rectifiers are also used.

10.2 Generators — Generators are available in various output capacities. These are given in Appendix D.

10.3 Electrical Control — Variation of voltage and current is obtained at the plating tank by means of built-in controls in the rectifiers or generator itself. Whenever further control at the tank is required, resistance panels are used.

APPENDIX A

(*Clause* 3.2.1)

STEEL TANK LININGS FOR PRE-TREATMENT PROCESSES

SL No.	PROCESS	PLAIN STEEL	LEAD LINED	RUBBER LINED	PLASTIC LINED	ENAMEL-LED IRON	STONE-WARE	STAINLESS STEEL
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	Alkaline cleaners	R	U	U	U	S	U	—
ii)	Cyanide cold cleaners	R	U	S	S	S	S	—
iii)	Acid dips:							
	1) Dilute sulphuric acid	U	R	S	S	S	S	U
	2) Dilute hydrochloric acid	U	U	R	R	S	S	U
	3) Dilute hydrofluoric acid	U	U	R	R	U	U	U
	4) Sulphuric acid etch	U	R	U	U	S	S	U
	5) Aquafortis bright dip	U	U	U	R	S	R	R
	6) Chrome sulphuric acid	U	S	U	U	S	R	R
iv)	Stripping solutions for nickel	U	R	U	U	S	S	U
v)	Caustic soda for chrome	R	U	S	S	S	U	U

R = Recommended, S = Suitable, U = Unsatisfactory.

APPENDIX B

(*Clause* 3.2.1)

TANK LININGS FOR ELECTROPLATING SOLUTIONS

SL No. (1)	PROCESS (2)	PLAIN STEEL (3)	LEAD LINED (4)	RUBBER LINED (5)	PLASTIC LINED (6)	ENAMELLED IRON (7)	STONEWARE (8)	STAINLESS STEEL (9)
i)	Dull nickel	U	R*	R	S	S	S	U
ii)	Bright nickel	U	U	R‡	S	S	S	U
iii)	Chromium	U	R†	U	S	S	U	U
iv)	Copper:							
	1) Cyanide	R*	U	S	S	S	S	U
	2) Bright	R*	U	S‡‡	S	S	S	U
	3) Acid	U	R*	R	S	S	S	—
v)	Brass	R	U	S	S	S	S	U
vi)	Silver	S*	R*	R	S	S	S	U
vii)	Gold	U	U	U	U	R	U	R§
viii)	Cadmium	R	U	R	S	S	S	U
ix)	Zink cyanide	R	U	R	S	S	S	U
x)	Tin cyanide	R	U	S	U	S	U	U
xi)	Acid solution	U	R*	R	S	S	S	U
xii)	Lead	U	U	R	S	S	S	U
xiii)	Anodic oxidation:							
	1) Chromic acid	R	S	U	S	S	S	S
	2) Sulphuric acid	U	R	S	S	S	S	U

R = Recommended, S = Suitable, U = Unsatisfactory.

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*With, preferably, a loose inner lining of reinforced glass or plastic sheets.

†Special alloy lead with a loose inner lining of reinforced glass or plastic sheets.

‡Special quality rubber pre-treated with hot dilute acid.

‡‡Special quality rubber pre-treated with hot dilute alkali.

§Stainless steels of widely differing composition are available. It is, therefore, important when ordering stainless steel tanks that the process be specified.

APPENDIX C

(*Clause* 10.1.2)

OUTPUT AND VOLTAGE RANGE OF PLATING RECTIFIERS

C-1. SINGLE-PHASE SETS OPERATING FROM 240 VOLTS NOMINAL, 50 c/s, SINGLE-PHASE AC SUPPLY

Output		Voltage Range
Amperes	Volts	
(1)	(2)	(3)
100	4	1-4
250	4	1-4
100	6	1·5-6
250	6	1·5-6
50	12	4-12
125	12	6-12
250	12	6-12

C-2. THREE-PHASE SETS OPERATING FROM 415 VOLTS NOMINAL, 50 c/s, THREE-PHASE AC SUPPLY

Output		Voltage Range
Amperes	Volts	
(1)	(2)	(3)
250	7·5	3-7·5
500	7·5	3-7·5
500	7·5	1·5-7·5
750	7·5	3-7·5
750	7·5	1·5-7·5
1 000	7·5	3-7·5
1 000	7·5	1·5-7·5
1 500	7·5	3-7·5
1 500	7·5	1·5-7·5
2 000	7·5	3-7·5
2 000	7·5	1·5-7·5
3 000	7·5	3-7·5
3 000	7·5	1·5-7·5
4 000	7·5	3-7·5

(*Continued*)

Output		Voltage Range
Amperes	Volts	
(1)	(2)	(3)
4 000	7·5	1·5-7·5
5 000	7·5	3-7·5
6 000	7·5	3-7·5
250	12	—
250	12	4·8-12
250	12	2·4-12
250	12	0-12
500	12	—
500	12	4·8-12
500	12	2·4-12
500	12	0-12
750	12	—
750	12	4·8-12
750	12	2·4-12
750	12	0-12
1 000	12	—
1 000	12	4·8-12
1 000	12	2·4-12
1 000	12	0-12
1 500	12	—
1 500	12	4·8-12
1 500	12	0-12
2 000	12	—
2 000	12	4·8-12
2 000	12	0-12
3 000	12	—
3 000	12	4·8-12
3 000	12	0-12
5 000	12	—
5 000	12	4·8-12
5 000	12	0-12
250	16	—
250	16	6·5-16
250	16	3·5-16
250	16	0-16
500	16	—
500	16	6·5-16
500	16	3·5-16
500	16	0-16
1 000	16	—

OUTPUT		VOLTAGE RANGE
Amperes	Volts	
(1)	(2)	(3)
1 000	16	6·5-16
1 000	16	0-16
1 500	16	—
1 500	16	6·5-16
1 500	16	0-16
2 000	16	—
2 000	16	6·5-16
2 000	16	0-16
2 500	16	—
2 500	16	6·5-16
2 500	16	0-16
3 000	16	—
3 000	16	6·5-16
3 000	16	0-16

APPENDIX D

(*Clause* 10.2)

OUTPUT DETAILS OF GENERATORS

OUTPUT		APPROXIMATE rpm	APPROXIMATE HORSE-POWER REQUIRED TO DRIVE
Amperes	Volts		
15	6	1 850	$\frac{1}{4}$
15	10	2 100	$\frac{1}{8}$
30	6	2 800	$\frac{1}{2}$
30	6	1 850	$\frac{1}{2}$
30	8	2 200	$\frac{5}{8}$
30	10	2 400	$\frac{3}{4}$
50	6	2 800	$\frac{3}{4}$
50	6	1 450	$\frac{3}{4}$
50	8	1 750	$\frac{7}{8}$
50	10	2 200	$1\frac{1}{4}$
100	6	1 450	$1\frac{1}{2}$
100	8	1 700	$1\frac{3}{4}$
100	10	1 850	$2\frac{1}{4}$

(*Continued*)

OUTPUT		APPROXIMATE rpm	APPROXIMATE HORSE-POWER REQUIRED TO DRIVE
Amperes	Volts		
150	6	1 200	2
150	8	1 350	2½
150	10	1 450	3
250	6	1 200	3
250	8	1 350	4
250	10	1 450	5
500	6	1 450	6
500	8	1 450	7½
500	6	960	6
500	8	960	8
500	10	1 200	9
750	6	850	8
750	8	960	11
750	10	960	13
1 000	6	720	10½
1 000	8	960	13½
1 000	10	960	17½
1 500	6	720	15
1 500	8	960	20
1 500	10	960	25
2 000	6	720	20
2 000	8	720	27
2 000	10	960	32
3 000	6	575	30
3 000	8	575	40
3 000	10	720	50
5 000	6	360	50
5 000	8	485	67
5 000	10	485	85

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

QUANTITY	UNIT	SYMBOL
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

QUANTITY	UNIT	SYMBOL
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

QUANTITY	UNIT	SYMBOL	DEFINITION
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2

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